PREVENTIVE MAINTENANCE AND TESTING OF ELECTRICAL EQUIPMENT IN HEALTH CARE FACILITIES

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TABLE OF CONTENTS

PROJECT GROUP PAGE

1. SUMMARY ..... 1.
2. INTRODUCTION ..... 2.
3. PRINCIPLES IN PLANNING AND DEVELOPING A PREVENTIVE MAINTENANCE AND TESTING PROGRAM OF ELECTRICAL EQUIPMENT ... 3.
4. PRIMARY SUBSTATIONS ..... 5.
5. HIGH VOLTAGE CABLES ..... 6.
6. HIGH VOLTAGE SWITCHGEAR ..... 7.
7. POWER TRANSFORMERS ..... 8.
8. HIGH VOLTAGE FUSES ..... 9.
9. LOW VOLTAGE SUBSTATIONS ..... 10.
10. PROTECTIVE SYSTEM STUDY ..... 13.
11. RELAYS ..... 15.
12. ROTATING MACHINERY ..... 17.
13. MOTOR STARTERS CONTROL CENTRES AND CONTROL DEVICES ..... 19.
14. POWER AND LIGHTING PANELS ..... 20.
15. ASKARELS ..... 21.
16. APPENDICES ..... 25.

1.0 SUMMARY

1.1 The requirements and recommendations in this guide outline a systematic program of preventive maintenance and testing of electrical equipment in health care facilities.

1.2 This guide does not supersede, negate, or alter the maintenance and test instructions issued by the manufacturers of equipment.

1.3 This guide does not include preventive maintenance and testing of diagnostic therapeutic and biomedical equipment.

1.4 This guide does not include preventive maintenance and testing of elevating devices and conveyors.

2.0 INTRODUCTION

2.1 Health care facilities depend on the continuous supply of electricity and the functioning of electrical equipment and systems. To increase the reliability of the electrical equipment and systems in health care facilities, proper maintenance and periodic testing must be conducted. Electrical components and equipment deteriorate in time due to normal use, and the rate of deterioration is a factor of load, environment, overloads, and severe duty cycles.

2.2 Certain sections of electrical equipment are also subject to damage through normal and abusive use of the equipment. Preventive maintenance and testing will reduce the danger of sudden failure of equipment, reduce the possibility of shock, and extend the life of the equipment.

2.3 In health care facilities, unscheduled shutdowns due to breakdown of equipment are not only costly but may involve undue hazard to patients and operating personnel. Periodic maintenance and testing will allow for repair and replacement of equipment at a convenient time to both the users and the maintenance staff.

3.0 PRINCIPLES IN PLANNING AND DEVELOPING A PREVENTATIVE MAINTENANCE AND TESTING PROGRAM OF ELECTRICAL EQUIPMENT

3.1 This guide deals with the preventive maintenance of electrical equipment. The principle in setting up a maintenance program depends on a number of factors.

3.1.1 A budget and appropriate funds shall be allocated for the carrying of the maintenance program.

3.1.2 A complete list of equipment and electrical systems shall be compiled. This list shall include manufacturer's operating manuals, single line diagrams, and all other pertinent information. The collected information shall be assembled by qualified personnel, classified as to the equipment and the required maintenance intervals, and tabulated in accordance with the required maintenance frequency.

3.1.3 Qualified staff, either in-house or contracted out, must be available to carry out the maintenance progam. Management and maintenance staff shall establish a policy as to the systems and equipment to be maintained by the in-house staff, and that to be contracted out. Management shall be responsible to monitor the reports and decide on actions to be taken.

3.1.4 Accurate records must be kept on all maintenance, testing, inspection and replacements.

3.1.5 The procedures and intervals mentioned within this guide shall be considered as minimum requirements, and shall be reviewed periodically as dictated by environmental conditions and frequency of use.

3.1.6 In designing a new system and commissioning of same, care shall be taken to provide adequate space, bypass feeders and means of maintaining essential equipment without lengthy power shutdowns. In some of the existing facilities, it may be necessary to plan changes in the systems and equipment in order to provide for easier future maintenance of the essential systems.

3.1.7 The maintenance staff must be thoroughly familiar with systems used in the health care facility. In larger systems, the maintenance staff must be fully aware of built-in bypass feeders and emergency operation measures which have been designed into the system. System diagrams, schematics, as built drawings and shop drawings are required. Documents shall be updated and if not available shall be prepared by competent staff to enable evaluation and location of trouble on a system. Special emergency features shall also be developed in order to deal with unexpected breakdowns.

3.1.8 Appropriate forms incorporating the following basic information shall be prepared. These forms shall be kept in a master file and shall be available to the maintenance staff. The maintenance staff shall use these forms for compiling information obtained during the inspection, testing and repair.

A. Name of equipment.

B. Frequency of required maintenance.

3.1.8 (cont'd)

C. Pertinent information and instruction about equipment and systems to be serviced.

D. Special information required for maintenance purposes such as manufacturer's instructions, shop drawings, and wiring diagrams.

E. Special tools, material, and equipment necessary for testing and maintenance.

F. Estimated time required to complete inspection and maintenance.

G. Spare parts list complete with catalogue numbers and notations as to equipment and components which have long delivery dates.

H. Record of last inspection and maintenance work performed.

3.1.9 The maintenance department shall carry adequate stock of spare parts for equipment maintained by the in-house staff.

3.1.10 Scheduling of maintenance shall be co-ordinated with administrative and operating staff. Visual inspections, measurement of temperature and loads, which can be performed without the shutdown of equipment may be carried out during regular working hours. Equipment which must be removed from service for maintenance purposes shall be grouped and divided in small sections so that only a portion of the system or facility or department is shut down at any one time. The administrative and operating staff shall be advised of the time and duration of such shutdown, and the shutdown shall be co-ordinated with persons responsible for the facility.

3.1.11 The maintenance staff shall be present during commissioning and testing of new installation of electrical components, equipment, and systems, in order that they may be fully acquainted with the systems and equipment which they will have to maintain.

3.1.12 Complete maintenance and operating instructions, shop drawings of electrical equipment, special tools shall be kept in appropriate storage cabinets.

4.0 PRIMARY SUBSTATIONS

4.1 For indoor type substations, building maintenance shall include an annual visual inspection of roofing, flashings, exposed metals, caulking, water leaks, brick, mortar joints, painting, locking provisions, electrolysis explosive conditions, ventilation openings, and ventilation fans and motors, and warning signs.

4.2 For outdoor type substations, structures, posts, fences and warning signs shall be visually inspected on an annual basis.

4.3 Electrical testing shall be performed as required.

4.4 There shall be specific written reports covering maintenance procedures instituted. The following report forms have been included to indicate the areas of inspection.

4.5 Refer to Appendix I for suggested report forms.

I A Report form for substation inspection and maintenance.

I B Sample of completed form for substation inspection and maintenance.

5.0 HIGH VOLTAGE CABLES

5.1 High voltage cables shall be inspected visually on an annual basis and findings shall be recorded. Records shall be arranged so as to facilitate comparison of inspections from previous years and commissioning results.

5.2 When cable failures occur, an accurate record of a failure report shall be completed and recorded on a cable failure report form.

5.3 Refer to Appendix II for suggested inspection forms.

II A Table of visual inspection for high voltage cables.

II B Record of Cable Failure Report.

6.0 HIGH VOLTAGE SWITCHGEAR

6.1 This section shall deal with indoor and outdoor metal enclosed and open type high voltage switchgear.

6.2 The term switchgear includes load break switches, interrupting devices, relay and control panels, instrument transformers and metering, conductors, busways, associated supporting structure and metal enclosures.

6.3 Prepare single diagram of your installation. Refer to Appendices III and IV for typical arrangements.

6.4 The maintenance of switchgear at the manufacturer's recommended intervals is essential to ensure uninterrupted supply of electricity to the facility, and it must not be neglected even though the switchgear is designed to meet the most onerous conditions of service.

6.5 In health care facilities switchgear and associated apparatus which are operated at infrequent intervals shall be visually inspected every year, and tested every five years. Local environmental conditions may require more frequent inspection and testing procedures.

6.6 Load interrupter switches and circuit breakers shall be exercised once a year. Circuit breakers shall be tripped both manually and electrically at least three times to ensure that their operating mechanisms and electrical circuits are functional.

Note: Above list shall be expanded as required.

6.7 Refer to Appendix V for suggested inspection forms.

VA Report form for annual high voltage switchgear inspection and maintenance record.

VB Report form for high voltage incoming structure and switchgear maintenance record.

VC Report form for inspection and testing of high voltage oil circuit breakers.

VD Report form for inspection and testing of unit indoor substation high voltage switch.

VE Report form for inspection and testing of high voltage air circuit breakers and associated equipment.

VF Report form for inspection and testing of oil switches.

VG Report form for inspection and testing of minimum content oil circuit breakers.

7.0 POWER TRANSFORMERS

7.1 Maintenance of power transformers is imperative in order to ensure a high degree of reliability and reduce transformer failure to a minimum. The maintenance of transformers is divided into two main types according to the insulating medium utilized, being a liquid filled type or dry type.

7.2 The insulating medium is also dissipating the heat generated in the windings, therefore, its proper maintenance is related to the overall life expectancy and reliability of a transformer.

7.3 The liquid filled transformers utilize mainly mineral insulating oil or non flammable types such as Askarel or Silicone liquid.

CAUTION: Because of differences in specifications these shall not be interchanged without consultation and approval by the manufacturer.

7.4 Because of the environmental impact of Askarels which contain polychlorinated biphenyls, the manufacturer's instructions shall be followed closely with regard to their handling and disposal. Refer to Section 15 for further details.

CAUTION: Before testing liquid of the transformer check the type of liquid used. If Askarel is used do not take a sample due to problems outlined under Section 15. A sample shall be taken by a specially qualified company or agency.

7.5 Refer to Appendix VI for suggested inspection forms.

7.5.1 The inspection and testing forms under Appendix VI of the guide are developed to cover the general points, and shall be expanded or modified where necessary in order to suit specific types of transformers, and shall include specific recommendations of the respective manufacturer of the transformer.

VIA Report form for transformer inspection and maintenance.

VIB Report form for annual oil test results and analysis.

VIC Report form for Askarel test results and analysis (every three years).

VID Transformer summary form.

8.0 HIGH VOLTAGE FUSES

8.1 High voltage fuses protect the electrical equipment from damage due to overcurrent or heavy short circuit currents. The basic arrangement of a fuse consists of a fusible element and a fuse support or holder. The fusible element melts when subjected to fault or overload currents, thus limiting the energy flowing to a fault and minimizes mechanical and thermal stresses, providing the necessary protection to switchgear, cables and other apparatus.

8.2 When fuse replacements or inspection and maintenance is carried out, ensure that the circuit is de-energized and all safety regulations have been adhered to.

8.3 Although some types of fuses may be physically interchangeable, their electrical characteristics may not be compatible to the interrupting fault level and dielectric withstand strength, BIL (Base Impulse Level of insulation) of the circuit protected. The fuse interrrupting rating shall not be below the available fault current at the fuseholder.

8.4 Collect manufacturer's data and re-fusing instructions for all types of fuses in the health care facility. Replacements stock shall be complete and properly identified. Stock a set of spare fuses or refills for each type and rating used in this installation.

8.5 Fuse terminals shall be kept clean and polished. Silver plated surfaces shall not be abraded.

8.6 Refer to Appendix VII for suggested inspection forms.

VII A Report form for inspection and maintenance of fuses, and fuse holders.

9.0 LOW VOLTAGE SUBSTATIONS (600 VOLTS & LOWER)

9.1 Main Feeder Cables.

9.1.1 On an annual basis visually inspect cable jacket, cable sheath, insulation in cable for signs of corrosion, abrasion, mechanical damage and overheating. Check load with clamp-on ammeter on various cables to determine if there is an unbalance. Specifically check parallel cables to determine if cables on the same phase are carrying equal loads.

9.1.2 Every three years disconnect load from cable being tested and tighten all terminal connectors. Special attention shall be paid to aluminum cable termination for over-heating and corrosion. Aluminum terminals should have strands coated with antioxidization compound test insulation resistance of cable. Insulation resistance test shall be certified by a qualified person.

9.2 Switchgear (every three years).

9.2.1 Enclosure - clean and vacuum inside of overall enclosure. Inspect bus-bars and associated cables for signs of overheating, tightness of termination, and corrosion. Measure insulation resistance to ground and tighten bolts and screws of all terminals between phases. Minimum resistance shall be at least 1 M. OHM. If lower, investigate and correct.

9.2.2 Circuit breakers - test mechanical close/open operation of breaker. Withdraw draw breakers and inspect disconnecting contacts and connections. Clean and lubricate where applicable (check manufacturer's data). Remove arc chutes, inspect main arching contacts and arc chutes. Inspect dash pot fluid, clean dash pots and replace fluid where applicable.

9.2.3 The following tests are recommended to be conducted by a qualified testing agency:

Breakers with electromagnetic overloads.

Test tripping function of breaker on all phases using current injection method.

9.2.4 Electrically test tripping relay and determine pick up points of long time, short time and instantaneous elements where applicable. Test long time delay feature at least two points of the time current curve. Test short time and instantaneous tripping and setting of relays. Check tested valves and times against manufacturer's curves or co-ordination curves, if available. Measure and record breaker contact resistance with low resistance OHMETER (ducter).

9.2.5 Solid state breakers - test mechanical open/close operation of breaker. Check and record the following settings:

Long time pick up and delay where applicable.
Short time pick up and delay.
Instantaneous pick up.
Ground fault pick up and delay.
Measure and record breaker contact resistance with low resistance OHMETER (ducter meter or similar).

9.2.6 Molded case breakers - test mechanical open/close operation of breaker. Record trip rating of the breakers with a trip setting in excess of 600A.

9.2.7 Fused disconnect switches - test mechanical open/close operation. Check and record fuse size and type.

9.2.8 Instruments - verify functional operation of ammeter and voltmeter and check selector switches.

9.3 Dry type transformers.

9.3.1 On an annual basis:

9.3.1.1 Examine overall enclosure for rust.

9.3.1.2 Make sure all ventilating screens and coil ducts are clear of obstructions and clean.

9.3.1.3 Record ambient temperature of room and maximum temperature of transformer.

9.3.1.4 Measure and record loads on transformer.

9.3.2 Once every three years the following shall be measured and recorded by qualified persons on all transformers which are part of a unit substation:

9.3.2.1 Vacuum and clean interior enclosure where applicable.

9.3.2.2 Examine the transformer for visible signs of overheating on all bus connections on windings board or switch.

9.3.2.3 Insulation resistance (measurement and recording) of high voltage and low voltage. High to low when secondary is grounded. Low to high when primary is grounded.

9.3.2.4 Insulation resistance of secondary bus and/or cable.

9.3.2.5 Insulation test of primary bus and/or cable.

9.3.2.6 Check coil blocking to ensure against failure under short circuit conditions.

9.3.2.7 Check vibration isolators and report abnormal noise or vibrations.

9.4 Liquid filled transformer.

9.4.1 On an annual basis:

9.4.1.1 Inspect the transformer for leaks, excessive rust and any other deterioration.

9.4.1.2 Visually inspect all grounding.

9.4.2 Two types of insulating liquid are in common use:

Flammable mineral insulating oil.

Non-flammable insulating liquids.

9.4.2.1 These non-flammable insulating liquids may be detrimental to the environment and must be handled with caution and in strict compliance with manufacturers' recommendations, in particular with regard to disposal (refer to Section 15 for further details).

9.4.3 Once every three years the following shall be measured and recorded, by qualified persons, on all transformers which are part of a unit substation:

9.4.3.1 Inspect and clean all busings.

9.4.3.2 Inspect thermometer, liquid level indicator and detector relay and pressure relief devices.

9.4.3.3 Check all current carrying conductors for signs of overheating.

9.4.3.4 Check all terminations for loose connections.

9.4.3.5 Obtain sample liquid from transformer and submit to laboratory for the following tests:

Neutralization number
Colour
Interfacial tension
Dielectric strength
Specific gravity (Askarel)

9.5 Refer to Appendix VII for suggested inspection forms.

VII A Table of annual visual inspection for low voltage cables.

VII B Report form for inspection and testing of 600 volt circuit breakers (to be carried out every three years).

VII C Report form for solid state breaker test (to be carried out every three years).

VII D Report form for inspection and testing of secondary main switches and enclosures (to be carried out every three years).

VII E Report form for annual inspection and testing program of dry type transformers.

VII F Report form for inspection and testing of dry type transformers (to be carried out every three years).

VII G Report form for annual inspection and testing of liquid filled transformers.

VII H Report form for inspection and testing of liquid filled transformers (to be carried out every three years).

10.0 PROTECTIVE SYSTEM STUDY

10.1 A protective system study shall be done on the electrical power system every ten years, or whenever any substantial changes are made to the system.

10.2 At commencement of the study, the following information shall be assembled:

10.2.1 The design and existing supply fault level.

10.2.2 The supply protective device settings.

10.2.3 The electrical distribution system layout.

10.2.4 The power system operating philosophy.

10.2.5 Transformer impedences and connections.

10.2.6 Neutral grounding methods used.

10.2.7 Length, size and type of cables.

10.2.8 Length, size and type of bus bar runs.

10.2.9 Types and sizes of motor leads.

10.2.10 Current transformer and potential transformer ratios.

10.2.11 Generator decrement curve.

10.2.12 Types and settings of existing protective devices, including time current characteristic curves.

10.3 The study will include all devices from the incoming supply down to and including the longest circuit breakers in panel boards.

10.4 A single line diagram showing all pertinent features of the power system shall be drawn. Information shown shall include items such as:

Voltage levels
Fault current levels
Transformer information
Cable data
Fuse data
Circuit breaker data

10.5 Fault current calculations shall be carried out. Both symmetrical and asymmetrical fault currents, and where applicable, ground fault currents shall be calculated for each point in the power system where protective devices are applied.

10.6 A check shall be made on all protective devices in the power system to ensure that each device is operating within its continuous current and fault interruption capacities, using the data calculated in 10.5 above. Any discrepancies shall be noted in the final report, along with recommendations.

10.7 For one portion of the power system at a time, damaged curves shall be drawn for all apparatus such as transformers, and cables in that portion of the system, on standard size log-log paper. Also such things as expected transformer inrush currents, and fault currents shall be drawn.

10.8 On the same piece of paper the time current characteristic curves of devices protecting relevant system apparatus shall be drawn.

10.9 The curves shall be examined to ensure that:

A. Apparatus is protected from overloads, grounds faults and short circuits.

B. The protective device closest to the fault, or overload condition is the first to operate and clear the fault. This also applies to ground fault situations.

10.10 If the requirements of 10.9 are not met, select devices and settings, and draw curves for settings which will achieve both requirements. If both cannot be achieved, requirement (A) should generally take precedence.

10.11 After all curves have been drawn in their final state, a list of recommendations shall be drawn up. These shall include:

A. Proposed device changes due to undercapacity.

B. Proposed changes to system configuration.

C. Proposed settings of protective devices.

10.12 Also tests of protective system operation shall be carried out to ensure that tripping circuits and circuits from the sensors to the protective device are intact and operating correctly. This should be carried out on commissioning new equipment and usually need only be done once during the life of the equipment. For existing equipment, for which this test has not been carried out during commissioning, arrangements should be made to have this done at the earliest convenient time.

11.0 RELAYS

11.1 Types of relays.

11.1.1 Relays used in power systems perform two functions:

I) Protection.

II) Control.

11.1.2 Protective relays are used in a power system to sense abnormal and dangerous conditions in the system, or in components of the system, and to operate in a manner that will either correct or reduce the effect of the condition. These relays usually sense the magnitude of and relationships between voltages and currents in the power system. They are either connected directly in the power system or fed by current transformers and potential transformers. Their output is usually a signal which operates another device in the power system.

11.1.3 Control relays are used in a power system to perform various functions in the operation of the system, such as circuit breaker opening and closing, and transfer of control power from one source to another.

11.2 Inspection of relays.

11.2.1 Once per year each relay shall be inspected visually, without removal from its case, for signs of overheating, arcing, dust buildup, foreign bodies in mechanisms, and signs of loose connections. The relay need not be removed from the panel for inspection unless it is of the drawout type which can be removed easily without affecting the normal functioning of the system.

11.2.2 Every three years the relays shall be disconnected and thoroughly tested for correct operation. The tests to be conducted will vary according to the type of relay being tested but essentially the tests consist of duplicating operating conditions and checking for correct operations. Currents and/or voltages of the correct magnitudes, phase relationships, and frequencies are applied to the input terminals of the relay and the output terminals monitored to tests for operations, which is indicated by opening or closing of contacts, or appearance or disappearance of a voltage or current. The relay should not operate when "normal" conditions are simulated, but should operate in the correct time when abnormal conditions are simulated. For electromechanical relays, insulation resistance should be measured.

11.2.3 In general, the tests listed by the manufacturer of the relay shall be carried out as the minimum test required for a relay. The tests shall include whichever of the following tests can be carried out on the particular relay:

I Pickup value of applied current, voltage, phase angle, frequency or any relevant combination of these values.

11.2.3 (continued)

II Drop-out value of applied current, voltage, phase angle, frequency or any relevant combination of these values.

III Timing of operation of the relay, for inverse time relays, two points on the curve shall be determined.

IV For differential relays, the relay shall not operate on a through fault, i.e. the same current through all operating coils, but shall operate at the correct difference in current.

V Unless otherwise specified, the tolerance on pick-up and drop-out voltages and currents shall be +/- 2%. The tolerance on operating times shall be +/- 2%, or 1 cycle.

VI On electromagnetic relays, the insulation resistance as measured with a 1000 volt instrument shall be at least 1 MEG-OHM.

VII On relays with targets, target operation and pick-up current shall be tested.

VIII The test equipment shall be capable of supplying all required combinations of voltages and currents and shall include frequency generators and phase shifters as required.

11.2.4 Refer to Appendix IX for sample test reports for various commonly used relays.

IX A Test report, overcurrent relay.

IX B Test report, overvoltage or undervoltage relay.

IX C Test report, type CA percent differential relay.

IX D Test report, type CW relay.

12.0 ROTATING MACHINERY

12.1 Improved design and construction methods have made motors one of the most dependable forms of machinery and their maintenance is comparatively simplified. The most vital and vulnerable features are those of proper lubrication and protection of the insulation. The recommendations under this section are not intended to cover detail maintenance requirements, therefore manufacturer's manual shall be consulted.

12.2 Lubrication
Oils and greases shall be of the approved type and grade. Automotive types in general are not suitable for most motor bearings applications.

12.3 Sleeve Bearings
For metallic sleeve bearings lubrication, turbine lubricating oil is recommended. The viscosity of the lubricating oil chosen is related to the operating temperature and the speed of the motor. Overheating of bearings may be caused by a number of reasons, including too much oil, wrong type of oil. Recurring failures of bearings on the same type of motor should always be referred to the motor manufacturer. For normal service recommended lubrication periods shall not exceed one year.

12.4 Ball and Roller Bearings
Most motors are equipped with sealed and prelubricated ball bearings which enable the motor to run for a substantial period of trouble-free operation. However, a number of motors are still shipped from manufacturers with greasable type of bearings. When greasing is required the manufactueres' instructions shall be followed closely. Over greasing is objectionable and it can cause not only overheating of bearings but destruction as well. Frequency of regreasing will vary wtih service and horsepower rating of motor.

12.5 Recommended frequency of regreasing follow manufacturers' instructions.

		HORSEPOWER	
SERVICE	BELOW 10	10 - 50	ABOVE 50
Standard	Every 5 years	Every 3 years	1 year
Severe	Every 3 years	Every year	Every 6 months

12.6 Insulation
The location of most motors is such that a certain degree of dust, dirt, and moisture can be accumulated in the windings, lowering the insulation resistance and reducing creepage distances. The recommended value of the insulation resistance can be determined from the following formula:

$$\text{MEGAOHMS} = \frac{\text{Rated voltage of the motor}}{\frac{\text{KVA rating}}{100} + 1000}$$

12.6.1 New motors and motors in good condition have a much higher value than the one determined from the above formula. It is recommended that the service dictates the frequency of testing and inspection.

12.7 Ordering Information

When a motor is to be replaced ensure that an appropriate motor for the application is selected.

12.8 Special Enclosures for Motors

In sprinklered areas motors of the dripped off type should be used. Ventilation openings for these motors are designed to prevent any solids or liquids falling on the machine of any angle greater than 15 degrees from the vertical, from entering into it and thus affecting its operation.

When ordering motors the following information should be included on the order form.

12.9 For sample forms refer to Appendix X.

X A Motor Order Form

X B Rotating Machine History Card

13.0 MOTOR STARTERS CONTROL CENTRES AND CONTROL DEVICES

13.1 On an annual basis:

13.1.1 Clean inside the overall enclosure.

13.1.2 Check and tighten control wires, power cables and busbar connections.

13.1.3 Check condition of main and arcing contacts and clean.

13.1.4 Check fuses for overheating. Record type and size of fuse used.

13.1.5 Test mechanical and electrical operation of starter.

13.1.6 Check contactor solenoids for overheating and noise.

13.1.7 Check overload relays against motor nameplate current values.

13.1.8 Test breakers for mechanical on-off operation.

13.2 Refer to Appendix XI for suggested inspection forms.

XI A Report form for annual inspection and testing program for motor starters.

14.0 POWER AND LIGHTING PANELS

14.1 On an annual basis:

14.1.1 Check enclosure for rust marks and other signs of deterioration.

14.1.2 Test all breakers for open-close operation.

14.1.3 Check completeness of legend and bring up-to-date.

14.1.4 Check the operating temperature of each breaker.

14.1.5 Remove the cover of the panel and check terminals for loose connections and signs of overheating.

14.1.6 Clean the inside enclosure of panels.

14.1.7 Check loads and ensure that no feeders are overloaded.

14.1.8 Check balancing of loads on each feeder.

14.1.9 Check and record voltage on each phase.

14.1.10 Refer to Appendix XII for suggested inspection forms.

XII A Report form for annual panel inspection and testing.

15.0 ASKARELS

15.1 Description and uses of Askarel.

15.1.1 The term "Askarel" is used to define a class of chlorinated hydrocarbon liquids. Most of these liquids contain one or more varieties of polychlorinated biphenyls (PCB's) together with other chlorinated hydrocarbons. Most Askarels contain over 40% chlorine by weight and have specific gravities between 1.35 and 1.55 and when non-contaminated, are clear in colour. Askarels are chemically stable, heat stable, fire resistant and non-explosive.

15.1.2 Because of their fire resistant properties, Askarels have been used extensively since 1932 by transformer manufacturers for indoor, rooftop and other locations; and by manufacturers of capacitors. The dielectric strength, resistivity, dielectric constant and non-sludging properties have made it an extremely good insulating and cooling medium for these devices.

15.2 Hazards involved with Askarels.

15.2.1 Since the late 1960's concern has arisen over the effect of Askarels on health and the environment.

15.2.2 Askarels are chemically very stable and are soluble in fat, therefore they are persistent in the environment and tend to remain in animal tissue.

15.2.3 Askarels are now considered to be a long term danger to human and animal health, as well as having short term effects.

15.2.3.1 The specific long term effects are not yet well documented but the short term effects include:

15.2.3.1.1 When swallowed in quantities exceeding one ounce Askarel may cause severe irritation of the digestive tract, and internal reactions.

15.2.3.1.2 High concentrations of Askarel vapour in the air will cause irritation of the eyes, nose and upper respiratory tract. Very high concentrations may cause internal reactions. Since Askarels evaporate slowly at room temperature, the main area of concern for Askarel vapours is in poorly ventilated areas, or when the fluid is heated or sprayed. Askarels have a distinctive odour which becomes obvious at concentrations lower than those which cause short term effects. Breathing apparatus should be used whenever there is any doubt concerning safety.

15.2.3.1.3 Askarels are moderate skin irritants when contact is of short duration, although they may be absorbed through the skin if contact is prolonged. Prolonged contact may permit solvent action on the oil and fats of the skin and may result in dermatitis.

15.3 Precautions.

15..3.1 Because of the hazards noted above and because of the long term persistence of Askarels in the environment, special precautions must be taken by all owners, users and handlers of Askarels and equipment using Askarels. Various government agencies have requirements which may overrule the recommendations listed below, so the following list should be taken as a guide:

15.3.1.1 Transformers and power capacitor containing Askarels and rooms should be clearly marked as to the contents. Most transformer supplies since 1972 are already marked in this manner.

15.3.1.2 A record of all equipment containing Askarel should be kept at one central location.

15.3.1.3 All personnel working in the area of Askarel containing equipment should be advised of the hazards inherent in the equipment.

15.3.1.4 Suitable dams, trip trays and catch basins of sufficient capacity to contain the total capacity of the device they enclose shall be constructed to contain any spills. All surfaces likely to come into contact with liquid should have smooth surfaces.

15.3.1.5 Where there is a possibility of moving objects hitting the equipment, guard rails or other protective barriers should be installed around the equipment.

15.3.1.6 All equipment shall be inspected once per week for leaks.

15.3.1 7 Care should be taken to operate the equipment within its capabilities, to minimize the risk of damage due to over-heating or mechanical forces.

15.3.1.8 If any maintenance work is required on Askarel filled equipment, it should only be carried out by trained experienced personnel, using materials which are not affected by Askarel. All materials used, and waste Askarel must be disposed of in an approved manner, with great care being exercised to ensure no Askarel escapes.

15.3.1.9 Water is the main enemy of Askarel, as far as its electrical properties are concerned, and extreme caution should be exercised to prevent water entering Askarel filled equipment. Likewise, regular mineral insulating oils should not be mixed with Askarels.

15.3.1.10 If any Askarel, or material which has been in contact with Askarel is to be disposed of, the provincial authorities should be notified, and either the original manufacturer of the equipment, or a firm recommended by the provincial authorities for this type of work should be hired. **Under no circumstances** should the liquid or material be dumped in the manner of normal waste.

15.3.2 If, despite all precautions, a spill occurs, or a person or material comes into contact with Askarels, the following steps should be taken:

15.3.2.1 The relevant authority, e.g. Ministry of the Environment shall be informed, and any instructions they give shall override the following list, if a conflict exists.

15.3.2.2 In the case of a spill, overflow, or leak, the first requirement is to contain the liquid and to prevent any liquid from getting into the environment. This shall be done by blocking sewers, building dams, enclosing material in plastic bags and/or cans, and soaking up the liquids with absorbent material.

15.3.2.3 Any liquid should be collected in good quality steel drums and the drums sealed tightly. Askarel soaked material such as rags, sawdust, paper, etc. should also be put into leak proof open-top drums with suitable gasketted lids. All drums should be clearly marked as to their contents. All other solid loose material contaminated with Askarel shall be contained in the same manner.

15.3.2.4 In major spills, direction of the appropriate authority shall be obtained.

15.3.2.5 All liquids and contaminated solids should be transported to an approved disposal organization.

15.3.2.6 In the case of a fire or the explosion of a transformer containing Askarels, gases including hydrogen chloride, carbon dioxide and some combustible gases may be given off. Caution shall be exercised in these cases to avoid injury from these gases.

15.3.2.7 Under no circumstances shall any attempt be made to burn Askarels. Askarels will only burn at very high temperatures and the products of combustion are hydrogen chloride, carbon dioxide and water vapour.

15.3.2.8 When working on a spill, or in any other way handling Askarel, the following minimum precautions shall be taken:

15.3.2.8.1 Avoid contact with the skin, by wearing neoprene gloves, aprons and goggles.

15.3.2.8.2 Use breathing apparatus when working in a confined or unventilated space or when Askarels are hot.

15.3.2.8.3 If Askarel gets into the eyes, flush with large amounts of water and refer the case to medical help.

15.3.2.8.4 If Askarel comes into contact with the skin, the area should be washed with warm soapy water.

15.3.2.8.5 Clothing which contacts Askarel shall be disposed of with other Askarel waste.

15.4 Special features of maintenance for Askarel filled equipment.

15.4.1 All the regular "external measurement" tests (ratio test, insulation resistance, etc.) shall be carried out on Askarel filled transformers.

15.4.2 A close examination for leaks and possible leaks shall be carried out.

15.4.3 Extra precautions shall be taken to prevent water entering, or Askarel leaving the transformer.

15.4.4 When taking samples for analysis, the sample should be taken from the top of the transformer tank and the container should itself be carried in another sealed, non-breakable container. Tests shall be carried out in accordance with the instructions outlined on form 5.3.2.3

15.4.5 Pumps, hoses and other equipment used for sampling Askarels should not be used for any other purposes.

16. APPENDICES

APPENDICES PAGE NO.

I. PRIMARY SUBSTATIONS

1.A. REPORT FORM FOR SUBSTATION INSPECTION AND MAINTENANCE 30

1.B. SAMPLE OF COMPLETED FORM FOR SUBSTATION INSPECTION AND MAINTENANCE 31

II. HIGH VOLTAGE CABLES

II.A. TABLE OF VISUAL INSPECTION FOR HIGH VOLTAGE CABLES 32

II.B. RECORD OF CABLE FAILURE REPORT 34

III. TYPICAL ARRANGEMENT OF PRIMARY SWITCHBOARD 36

IV. TYPICAL ARRANGEMENT OF OVERHEAD PRIMARY SUBSTATION ... 37

V. HIGH VOLTAGE SWITCHGEAR

V.A. REPORT FORM FOR ANNUAL HIGH VOLTAGE SWITCHGEAR INSPECTION AND MAINTENANCE RECORD 38

V.B. REPORT FORM FOR HIGH VOLTAGE INCOMING STRUCTURE AND SWITCHGEAR MAINTENANCE RECORD 39

V.C. REPORT FORM FOR INSPECTION AND TESTING OF HIGH VOLTAGE OIL CIRCUIT BREAKERS 40

V.D. REPORT FORM FOR INSPECTION AND TESTING OF UNIT INDOOR SUBSTATION HIGH VOLTAGE SWITCH 41

V.E. REPORT FORM FOR INSPECTION AND TESTING OF HIGH VOLTAGE AIR CIRCUIT BREAKERS AND ASSOCIATED EQUIPMENT 42

V.F. REPORT FORM FOR INSPECTION AND TESTING OF OIL SWITCHES 43

V.G. REPORT FORM FOR INSPECTION AND TESTING OF MINIMUM CONTENT OIL CIRCUIT BREAKERS 44

V.I. POWER TRANSFORMERS

VI.A. REPORT FORM FOR TRANSFORMER INSPECTION AND MAINTENANCE 45

APPENDICES (CONTINUED)

PAGE NO.

VI.B. REPORT FORM FOR ANNUAL OIL TEST RESULTS AND ANALYSIS 48

VI.C. REPORT FORM FOR ASKAREL TEST RESULTS AND ANALYSIS (EVERY THREE YEARS) 50

VI.D. TRANSFORMER SUMMARY FORM 51

VII. HIGH VOLTAGE FUSES

VII.A. REPORT FORM FOR INSPECTION AND MAINTENANCE OF FUSES AND FUSE HOLDERS 52

VIII. LOW VOLTAGE SUBSTATIONS

VIII.A. TABLE OF ANNUAL VISUAL INSPECTION FOR LOW VOLTAGE CABLES 54

VIII.B. REPORT FORM FOR INSPECTION AND TESTING OF 600 VOLT CIRCUIT BREAKERS (TO BE CARRIED OUT EVERY THREE YEARS) 56

VIII.C. REPORT FORM FOR SOLID STATE BREAKER TEST (TO BE CARRIED OUT EVERY THREE YEARS) 58

VIII.D. REPORT FORM FOR INSPECTION AND TESTING OF SECONDARY MAIN SWITCHES AND ENCLOSURES (TO BE CARRIED OUT EVERY THREE YEARS) 59

VIII.E. REPORT FORM FOR ANNUAL INSPECTION AND TESTING PROGRAM OF DRY TYPE TRANSFORMERS 60

VIII.F. REPORT FORM FOR INSPECTION AND TESTING OF DRY TYPE TRANSFORMERS (TO BE CARRIED OUT EVERY THREE YEARS) 61

VIII.G. REPORT FORM FOR ANNUAL INSPECTION AND TESTING OF LIQUID FILLED TRANSFORMERS 63

VIII.H. REPORT FORM FOR INSPECTION AND TESTING OF LIQUID FILLED TRANSFORMERS (TO BE CARRIED OUT EVERY THREE YEARS) 64

IX. RELAYS

IX.A. TEST REPORT OVERCURRENT RELAY 66

IX.B. TEST REPORT OVERVOLTAGE OR UNDERVOLTAGE RELAY 67

IX.C. TEST REPORT TYPE CA PERCENT DIFFERENTIAL RELAY 68

IX.D. TEST REPORT TYPE CW RELAY 69

APPENDICES (CONTINUED)

PAGE NO.

X. ROTATING MACHINERY

X.A. MOTOR ORDER FORM 70

X.B. ROTATING MACHINERY HISTORY CARD 71

XI. MOTOR STARTERS CONTROL CENTRES AND CONTROL DEVICES

XI.A. A REPORT FORM FOR ANNUAL INSPECTION AND TESTING PROGRAM FOR MOTOR STARTERS 72

XII. POWER AND LIGHITNG PANELS

XII.A. REPORT FORM FOR ANNUAL PANEL INSPECTION AND TESTING 73

I. PRIMARY SUBSTATIONS

IA. REPORT FORM FOR SUBSTATION INSPECTION AND MAINTENANCE

HOSPITAL NAME: .....

LOCATION OF MAIN SUBSTATION: .....

REFERENCE NO. OR NAME OF SUBSTATION: .....

SCHEDULED DATE OF INSPECTION: .....

TIME: ..... COMPLETION DATE: .....

TIME TAKEN TO COMPLETE THE INSPECTION: ..... HOURS

GENERAL CONDITION AND APPEARANCE: *DIRTY/CLEAN/DUSTY/DAMP/WET*

DESCRIBE OTHERS: .....

SUBSTATION TEMPERATURE: DEGREES CENTIGRADE: SUMMER ..... °C

WINTER: ..... °C

OUTDOOR AMBIENT TEMPERATURE: DEGREES CENTIGRADE: SUMMER: ..... °C

WINTER: ..... °C

INSPECTED BY: NAME: ..... DATE: .....

TITLE: .....

APPROVED BY: ..... DATE: .....

ITEM	CONDITION	REMARKS
Roofing		
Exposed metals		
Brick mortar joints		
Painting		
Locking provisions		
Ventilation openings		
Warning signs		
Drain gratings		
Sump pump high water level alarm		
Ventilator motor		
Floor (Debrior Silt)		
Ceiling		
Cable hangers		
Grounding		
Ground rod connectors		
Transformer		
Oil leaks		
Lighting		
Intercom		
List additional items below		

NOTE: Where the Inspector feels that in addition to the visual inspection, a more thorough inspection should be carried out by a specialist or purchased services, this must be indicated in the report.

I. PRIMARY SUBSTATIONS

IB. SAMPLE OF COMPLETED FORM FOR SUBSTATION INSPECTION AND MAINTENANCE

HOSPITAL NAME: .....

LOCATION OF MAIN SUBSTATION: .....

REFERENCE NO. OR NAME OF SUBSTATION: .....

SCHEDULED DATE OF INSPECTION: .....

TIME: ..... COMPLETION DATE: .....

TIME TAKEN TO COMPLETE THE INSPECTION: ..... HOURS

GENERAL CONDITION AND APPEARANCE: *DIRTY/CLEAN/DUSTY/DAMP/WET*

DESCRIBE OTHERS: .....

SUBSTATION TEMPERATURE: DEGREES CENTIGRADE: SUMMER ..... °C

WINTER: ..... °C

OUTDOOR AMBIENT TEMPERATURE: DEGREES CENTIGRADE: SUMMER: ..... °C

WINTER: ..... °C

INSPECTED BY: NAME: ..... DATE: .....

TITLE: .....

APPROVED BY: ..... DATE: .....

ITEM	CONDITION	REMARKS
Roofing	—	*Does not apply*
Exposed metals	*O.K.*	*No action required*
Brick mortar joints	*Signs of deterioration*	*Reported separately*
Painting	*O.K.*	
Locking provisions	*O.K.*	
Ventilation openings	*Rusty*	*Painted 24/3/79*
Warning signs	*O.K.*	
Drain gratings	*None*	
Sump pump high water level alarm	*None*	
Ventilator motor	*Dirty*	*Cleaned 24/3/79*
Floor (Debrior Silt)	*Trash, papers, water*	*Cleaned 24/3/79*
Ceiling	*Dry but cracked*	*Reported separately*
Cable hangers	*O.K.*	
Grounding	*O.K.*	
Ground rod connectors	*O.K.*	
Transformer	*Dirty*	
Oil leaks	*None*	
Lighting	*O.K.*	
Intercom	*None*	
List additional items below		

NOTE: Where the inspector feels that in addition to the visual inspection, a more thorough inspection should be carried out by a specialist or purchased services, this must be indicated in the report.

II. HIGH VOLTAGE CABLES

II.A. TABLE OF VISUAL INSPECTION FOR HIGH VOLTAGE CABLES:

ITEM	O.K.	YEAR ..... REMARKS	O.K.	YEAR ..... REMARKS
Evidence of physical damage				
Existence of sharp bends				
Signs of excessive tension				
Signs of oil leaks				
Evidence of cable movement				
Insulation swelling				
Cracked jackets				
Damaged fireproofing				
Corroded ground connections				
Loose ground connections				
Signs of tracking or Corona				
Bottom surface of the cable scraped				
Cable identification tags attached				

II.A. TABLE OF VISUAL INSPECTION FOR HIGH VOLTAGE CABLES (Continued)

ITEM	O.K.	YEAR ..... REMARKS	O.K.	YEAR ..... REMARKS
Operating surface temperature of the cable				
Load on the cable				
Substation room temperature				
Size of cable				
Type of cable				
Operating voltage of cable				
Identification of cable				
Feeder name				
Pothead inspection for oil or Compound leaks				
Signs of cracked porcelain insulators				
Signs of chipped insulators				
Verify tightness of exposed connections				

Time taken to complete the inspection: .....

Date of inspection: .....

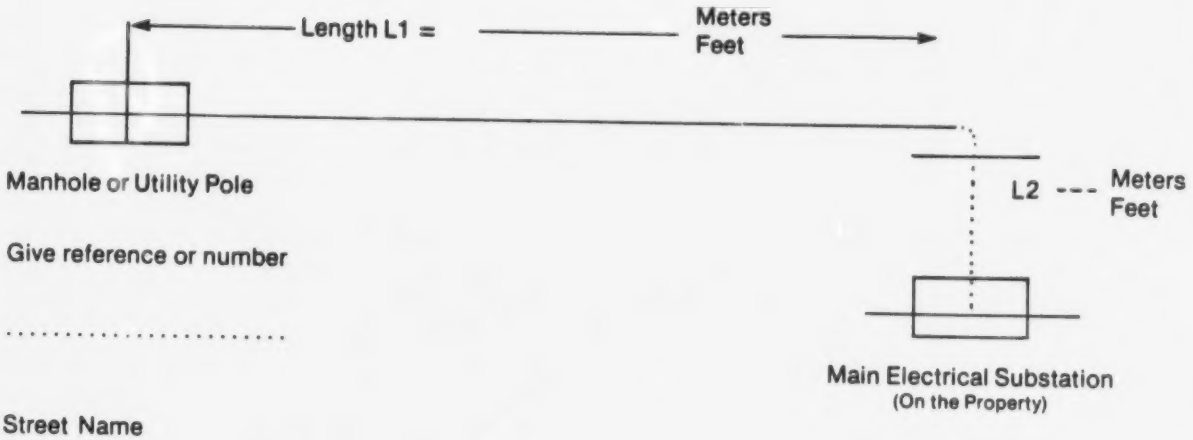
Inspected by: .....

Approved by: .....

NOTE: Above list shall be expanded as required.

II.B. RECORD OF CABLE FAILURE REPORT

ESSENTIAL DATA TO BE COMPILED WHEN A CABLE FAILURE OCCURS



Give reference or number

.....

Street Name

.....

1. Type of cable: Three or Single Conductor
   P.I.L.C., Cross-Link,
   Other .....

2. ☐ Aluminum/Copper ☐ Sector/Round ☐ Conductor
3. Size of cable .....
4. Size of duct ..... or Directly Buried ☐
5. Duct Formation Other

IIB. RECORD OF CABLE FAILURE REPORT (Cont'd)

6. Utility supply voltage.

7. Rated voltage of cable.

8. Cause of failure

.....
.....
.....
.....

Injury during installation, migration of compound, overheating due to overload or improper installation, failure of adjacent cable, deterioration of cable insulation, lightning, water in insulation undetermined.

9. Date cable installed .....

10. Failure occurred during Testing/In Service.

11. Action taken

.....
.....
.....
.....

12. Method used to locate the fault

.....

Tracer methods Modulated D.C., Modulated A.C., Audio Tone tracing, impulse, other.

13. Date and time of failure .....

14. Temporary installation .....
Description: .....
Date installed: .....

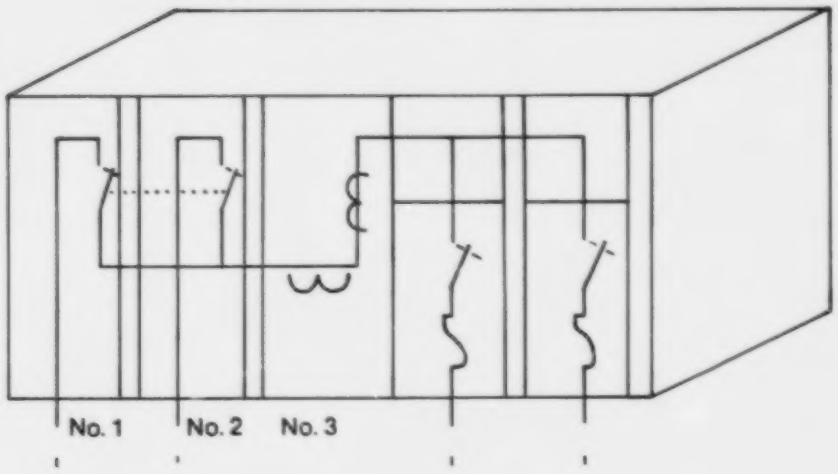
15. Permanent corrective measures .....
Description: .....
Date of completion of installation .....

16. Reported: NAME .....
TITLE .....

17. Approved by: .....

III TYPICAL ARRANGEMENT OF PRIMARY SWITCHBOARD

TWO INCOMING FEEDERS TWO TRANSFORMERS



1. This arrangement shows two incoming feeders into the two bays with load break switches and Kirk Key interlocks such that only one load break switch can be closed at any time.

2. The third bay accommodates the Public Utility's metering, current and potential, transformers.

3. Bays numbers 4 and 5 accommodate the fused load break switches supplying the step down transformers.

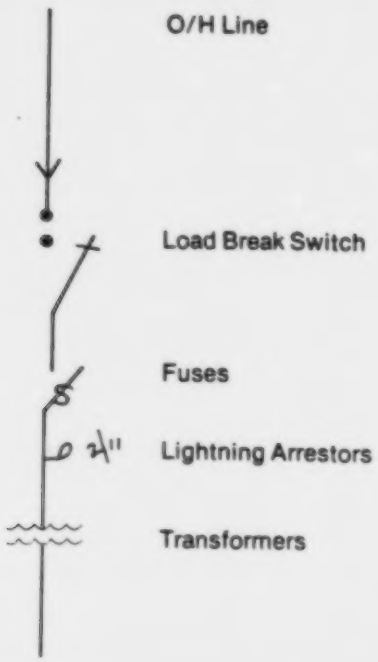
4. Also indicate type of switchgear to the transformer. (Throat connection, cable connection, metal enclosed bus.)

5. List normal operation of load break switches in bays 1 and 2, i.e. manual or automatic.

6. Indicate voltage, amperage and any other pertinent information.

7. List characteristics of spare fuses or fuse links.

IV TYPICAL ARRANGEMENT OF OVERHEAD PRIMARY SUBSTATION



For each equipment, list characteristics including voltage and amperage ratings.

List characteristics of spare fuses or fuse links.

V. HIGH VOLTAGE SWITCHGEAR

V.A. REPORT FORM FOR ANNUAL HIGH VOLTAGE SWITCHGEAR INSPECTION AND MAINTENANCE RECORD

NAME PLATE INFORMATION:

	REMARKS
Visual inspection of all access doors	
General lubrication of hinges, locks and latches	
Verification and cleaning of ventilation screens	
Cleaning of ventilation louvres	
Visual inspection of doors interior to ensure that there is no accumulation of moisture due to condensation	
Evidence of presence of excessive rust on the metal enclosure	
Verification of proper operation of space heaters inside the cubicles	
Verification of setting and operation of the space heater thermostat	
Evidence of arcing between insulator, and between an insulating member and a grounded metallic surface	
Verify existence of spare parts, maintenance and operating instructions special tools, fuse links and shop drawings	
Verification of tracking due to corona or other electrical discharge	
Evidence of high temperature, discolouration, cracking carbonization, leaking insulating compound	
If evidence of high temperature for hot spots exists, the use of infra-red thermography is recommended	

Recommendations and required follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

V.B. REPORT FORM FOR H.V. INCOMING STRUCTURE AND SWITCHGEAR MAINTENANCE RECORD (EVERY THREE YEARS)

	REMARKS
Visually inspect structure for rust and tightness of bolts	
Lubricate moving parts	
Clean and inspect porcelain bushings, insulators and lighting arrestors	
Inspect and adjust if necessary the operation of load break switches	
Inspect and clean all contacts	
Load break switches Fuse holders	
Inspect the grounding system and measure ground resistance and record	
Measure and record insulation resistance of all bus and associated cables	
Use a 5KV direct durrent insulation tester Record ambient temperature	
Clean and inspect potheads	
Inspect and tighten if necessary all connections	

Recommendations and required follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

V.C. REPORT FORM FOR INSPECTION AND TESTING OF H.V. OIL CIRCUIT BREAKERS (EVERY THREE YEARS)

NAME PLATE INFORMATION:

	REMARKS
A sample of oil would be drawn from the breaker tank and taken to a laboratory where it would be subjected to the following tests: a) Neutralization Number b) Colour c) Interfacial Tension d) Dielectric Strength	
Inspect for external damage, oil leakage, etc.	
Inspect and clean all bushings	
Measure in micro-Ohms resistance of breaker contacts and associated connections. Measurement shall be made between in-going and out-going terminals	
Lower tank and inspect mechanical operation and alignment of internal mechanism	
Measure insulation resistance. Use a 5KV direct current insulation tester	
Verify function of control circuitry	

Recommendations and required follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of Inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.

2. For outdoor oil circuit breakers test the oil dielectric strength annually.

3. Follow manufacturer's instructions.

V.D. REPORT FORM FOR INSPECTION AND TESTING OF UNIT INDOOR SUB H.V. DISCONNECT SWITCH (EVERY 3 YEARS)

NAME PLATE INFORMATION:

	REMARKS
Measure in micro-ohms and record insulation resistance of incoming cable using 5 KV insulating instrument	
Mechanical operation — inspect and adjust if needed	
Inspect and record condition of Interrupter heads	
Inspect and record condition of main and arcing contacts	
Measure in micro-ohms and record resistance of fuses by ducter tester	
Clean and inspect bushings for cracks, chips, etc.	
Lubricate necessary parts of interrupter switch	
Verify operation of overall interlock system	
Clean and vacuum complete compartment	
Clean contacts and apply contact lubricant where specified	

Recommendations and required follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of Inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

V.E. REPORT FORM FOR INSPECTION AND TESTING OF H.V. AIR CIRCUIT BREAKERS AND ASSOCIATED EQUIPMENT (EVERY THREE YEARS)

NAME PLATE INFORMATION:

	REMARKS
Thoroughly clean complete breaker, bus and bus supports and compartment	
Inspect buses and connections for evidence of overheating	
Measure and record the resistance to ground of each phase and with other phases grounded of the insulation of breakers, buses and connections using 5 KV D.D. insulation tester	
Clean racking mechanism and lubricate jack screws and gears	
Check primary disconnecting device contacts for signs of abnormal wear or overheating. Clean and apply a thin coat of lubricant, as specified. Check air shutes and puffer	
Check tightness, alignment and continuity of all contacts, connections and wiring	
Measure in micro-ohms and record resistance of contacts	

Recommendations and required follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

V.F. REPORT FORM FOR INSPECTION AND TESTING OF OIL SWITCHES (EVERY THREE YEARS)

NAME PLATE INFORMATION:

	REMARKS
A sample of oil to be drawn from the breaker tank and forwarded to laboratory for the following tests: a) Neutralization Number b) Colour c) Interfacial Tension d) Dielectric Strength	
Inspect for oil leakage and rusting	
Inspect mechanical operation contact condition, and interlocks	

Recommendations and required follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

V.G. REPORT FORM FOR INSPECTION AND TESTING OF MINIMUM CONTENT OIL CIRCUIT BREAKERS (EVERY THREE YEARS)

NAME PLATE INFORMATION:

	REMARKS
Inspect for external defects, oil leakage, etc.	
Check oil level and oil discolouration	
Check opening and closing operation	
Measure and record insulation resistance using a 5 KV direct current insulation tester. Measure in micro-ohms	
Inspect and clean	

Recommendations and required follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete tha inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

VI POWER TRANSFORMERS

VI.A. REPORT FORM FOR TRANSFORMER INSPECTION AND MAINTENANCE

Main transformer data

☐ Indoor ☐ Outdoor

Other (describe): .....

Transformer: ☐ Hospital owned ☐ Installed
☐ Utility owned

Name of utility: .....

Address: .....

.....

Telephone: .....

Transformer manufacturer: .....

Year of manufacture date: .....

Serial number: .....

Primary voltage: ..... Secondary voltage: .....

Frequency: .....

Quantity and type of liquid: .....

.....

Standard type designation: ☐ ONAN ☐ ONAF ☐ LNAN ☐ LNAF

NAME PLATE INFORMATION:

Transformer rating: KVA: .....
KW: .....

Maximum demand:

Summer ..... KVA ..... KW .....
Winter ..... KVA ..... KW .....
Spare capacity ..... KVA ..... KW .....

VI.A.(a) POWER TRANSFORMERS ANNUAL INSPECTION

	REMARKS
Level of insulating liquid	
Insulators condition if visible	
Liquid leaks	
Paint condition	
Temperature indicator Instant.	
Maximum	
Shut down required for further testing and repairs	
Test and operate cooling fans if applicable	

Recommendations and required follow-up:

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

VI.A.(b) INSPECTION AND TESTING (EVERY THREE YEARS)

Work to be carried out with the transformer de-energized

	REMARKS
Check bushings Clear bushings Liquid leaks from: Gasket Drain Valve Bus ring Obtain and test liquid sample	
Check tap changer and tightness of connections	
Measure ground connection resistance in Ohms	
Cooling fans operation	
Verify contacts condition in thermostat	
Insulation resistance Low voltage winding to ground with high voltage winding grounded	.....MegaOhms
High voltage winding to ground with low voltage winding grounded	.....MegaOhms
High voltage winding to low voltage winding	.....MegaOhms

HIGH VOLTS	LOW VOLTS	TAP POSITION	CALCULATED RATIO
		1	
		2	
		3	
		4	
		5	

Total down time for overhaul: Estimate: .....

Actual: .....

Cost of planned overhaul $ .....

Cost of repair parts $ .....

Tested and inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

VI.B. REPORT FORM FOR ANNUAL OIL TEST RESULTS AND ANALYSIS

Equipment type and reference: .....
Equipment location: .....

NAME PLATE INFORMATION:

Manufacturer: .....
Serial No.: .....
Year: .....
Oil type: .....
Quantity of oil: .....
Date of last test: .....
Date of last change: .....
Other information: .....
.....

Dielectric strength
25 KV Minimum

1st Test ..... KV 2nd Test ..... 3rd Test .....
4th Test ..... 5th Test ..... Average .....

Acidity MG/G (0.25 max.) or Potassium Hydroxide required to neutralize the acid in one gram of oil (max. 0.G.)
MG of KOH/gm.

Interfacial tension dynes/cm 18 minimum recommended: ..... DYNES/CM
Present condition of oil: .....
.....
.....
Colour test: ..... (Maximum colour No. is 4)
Poor ..... Good .....
Recommended replacement ☐
Treatment ☐

Recommendation and follow-up:

VI.B. REPORT FORM FOR ANNUAL OIL TEST RESULTS AND ANALYSIS

Tested by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's and testing agency's instructions.

VI.C. REPORT FORM FOR ASKAREL TEST RESULTS AND ANALYSIS (EVERY THREE YEARS)

NOTE: Follow manufacturer's instruction
Refer to Section 15 - Askarels for precautions of handling Askarel filled transformers.
Testing shall be done by a specially qualified company.

Equipment type and reference equipment location.

NAME PLATE INFORMATION:

Manufacturer: .....
Serial No.: .....
Year: .....
Liquid type: .....
Quantity of liquid: .....
Date of last test: .....
Date of last change: .....
Other information: .....
.....
.....

VI.D. TRANSFORMER SUMMARY FORM

REFERENCE	TRANSFORMER			DATE	COMMENTS
	Location	KVA Capacity	Load KVA		

VII. HIGH VOLTAGE FUSES

VII.A. REPORT FORM FOR INSPECTION AND MAINTENANCE OF FUSES AND FUSE HOLDERS (EVERY THREE YEARS)

NAME PLATE INFORMATION OF FUSE HOLDER or FUSE REFILL

....
....
....
....

Make: ....
Cat. No.: ....
Voltage: ....
Current rating: ....
Speed rating or curve no.: ....

ITEM	REMARKS		
FUSE HOLDER	PHASE		
	A	B	C
Discoloured due to heat			
Discoloured due to corrosion			
Signs of deterioration			
Verification of tightness of connections			
Measure in micro-ohms and record resistance of fuses (using a testing instrument as a ducter)			

VII.A. (Cont'd.)

CONTACT SURFACES	O.K.	REMARKS
Pitted		
Burned		
Out of alignment		
Miscellaneous		

Inspected by: Name: .....

Title: .....

Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

VIII. LOW VOLTAGE SUBSTATIONS

VIII.A. TABLE OF ANNUAL VISUAL INSPECTION FOR LOW VOLTAGE CABLES: — FOLLOW MANUFACTURER'S INSTRUCTIONS

ITEM	O.K.	YEAR ..... REMARKS	O.K.	YEAR ..... REMARKS
Evidence of physical damage				
Existence of sharp bends				
Signs of excessive tension				
Evidence of over heating				
Insulation swelling				
Cracked jackets				
Corroded ground connections				
Loose ground connections				
Proper ground connections for no sheath currents				
Cable identification tags attached				

VIII.A. TABLE OF ANNUAL VISUAL INSPECTION FOR LOW VOLTAGE CABLES (Cont'd) — FOLLOW MANUFACTURER'S INSTRUCTIONS

ITEM	O.K.	YEAR ..... REMARKS	O.K.	YEAR ..... REMARKS
Operating surface temperature of the cable				
Load on the cable				
Room temperature				
Size of cable				
Type of cable				
Operating voltage of cable				
Identification of cable				
Feeder name				
Verify presence of anti-oxidization compound for aluminum conductors				

Time taken to complete the inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTE: Above list shall be expanded as required.

VIII.B. REPORT FORM FOR INSPECTION AND TESTING 600 VOLT CIRCUIT BREAKERS (EVERY THREE YEARS)

NAME PLATE INFORMATION:

MAKE

SERIAL NO.

TRIP UNIT OR MONITOR RATING

SUBSTATION OR PANEL:

BREAKER TYPE:

FEEDER IDENTIFICATION:

	REMARKS
Check condition of main and arcing contacts and chutes	
Contact resistance (1,000v. Megger)	A B C
Phase to ground	A B C
Phase to phase	AB BC CA
Single phase coil voltage	A B C
Inspect dashpot die Clean dashpots Refill with new oil Check mechanical operation of trip units	
Lubricate all moving parts where necessary	
Check mechanical operation of air circuit breaker and contact equipment	

VIII.B. (Cont'd)

	AVAILABLE SETTINGS	AS FOUND	AS LEFT
Long delay pick-up			
Long delay time			
Short delay pick-up			
Short delay time			
Instantaneous pick-up			
Ground element pick-up			

	TEST AMPS	MFG LIMITS		AS FOUND			AS LEFT		
		MIN.	MAX.	A	B	C	A	B	C
Long delay pick-up ±									
Long delay time @ 165% @ 300% @ %									
Short delay pick-ups ± %									
Short delay time									
Instantaneous pick-up									

Time taken to complete inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

VIII.C. REPORT FORM FOR SOLID STATE BREAKER (EVERY THREE YEARS)

NAME PLATE INFORMATION:

MAKE

SERIAL NO.

TRIP UNIT OR MONITOR RATING

SUBSTATION OR PANEL:

BREAKER TYPE:

FEEDER IDENTIFICATION:

	REMARKS
Check condition of main and arcing contacts and chutes	
Contact resistance (1,000v. Megger)	A B C
Phase to ground	A B C
Phase to phase	AB BC CA
Single phase coil voltage	A B C
Lubricate all moving parts where necessary	
Check mechanical operation of air circuit breaker and contact equipment	

VIII.D. REPORT FORM FOR INSPECTION AND TESTING OF SECONDARY MAIN SWITCHES AND ENCLOSURES

NAME PLATE INFORMATION:

	REMARKS
Clean and vacuum inside of overall enclosures	
Check mechanical operation of switch	
Test contact resistance where possible	
Inspection of bus bar and associated cable for: a) Signs of overheating b) Tightness c) Corrosion, etc.	
Measure and record resistance of fuses (use a ducter tester or similar)	

Recommendations and follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required
2. Follow manufacturer's instructions.

VIII.E. REPORT FORM FOR ANNUAL INSPECTION AND TESTING PROGRAM OF DRY TYPE TRANSFORMERS

TRANSFORMER RATING: _____ KVA

PRIMARY VOLTAGE: _____ V SECONDARY VOLTAGE: _____ V

MAXIMUM DEMAND: _____ KVA A _____ AMPS B _____ AMPS C _____ AMPS

LOCATION: _____

NAME PLATE INFORMATION: _____

INSPECTION AND TESTING	REMARKS
Paint condition	
Ensure that all ventilating screens are clean	
Check alarm contact thermometer if provided	
Check and operate cooling fans Temp. indicator: Instantaneous	
Maximum	
Visually inspect the grounding	

Recommendations and follow-up:

Time taken to complete inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

VIII.F. REPORT FORM FOR INSPECTION AND TESTING OF DRY TYPE TRANSFORMERS (EVERY THREE YEARS)

TRANSFORMER RATING: _____ KVA

PRIMARY VOLTAGE: _____ V SECONDARY VOLTAGE: _____ V

MAXIMUM DEMAND: _____ KVA A _____ AMPS B _____ AMPS C _____ AMPS

LOCATION: _____

NAME PLATE INFORMATION: _____

INSPECTION AND TESTING	REMARKS
Check coil blocking to insure against failure under short circuit conditions	
Test insulation resistance of secondary bus or cable. Examine for visible signs of overheating on: All bus connections Overall winding Tap board or switch NOTE TAP POSITION	
Inspect tap switch or board for loose connections and lead clearance	
Clean and vacuum complete unit	
Insulation resistance: L.V. winding to Gnd. with H.V. winding grounded	Mega-Ohms.
H.V. winding to Gnd. with L.V. winding grounded	Mega-Ohms.
H.V. winding to low voltage winding	Mega-Ohms.
Check alarm contact thermometer or hot spot	

Planned overhaul every 3 years: ☐ Yes ☐ No

Other interval: ..... years

Total down time for overhaul: Estimated: .....

Actual: .....

Cost of planned overhaul: $ In-house staff

$ Contracted

Spare parts $ _____

TOTAL: $ _____

VIII.F. (Cont'd)

Recommendations and follow-up:

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

VIII.G. REPORT FORM FOR ANNUAL INSPECTION AND TESTING OF LIQUID FILLED TRANSFORMERS

TRANSFORMER RATING: _____ KVA

PRIMARY VOLTAGE: _____ V SECONDARY VOLTAGE: _____ V

MAXIMUM DEMAND: _____ KVA A _____ AMPS B _____ AMPS C _____ AMPS

LOCATION: _____

NAME PLATE INFORMATION: _____

INSPECTION AND TESTING	REMARKS
Level of insulating liquid	
Insulators condition if visible	
Liquid leaks	
Paint condition	
Temp. indicator	
Maximum	
Shut down required for further testing and repairs	
Test and operate cooling fans if applicable	
Visually inspect all grounding	

Recommendations and follow-up:

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instruction

VIII.H. REPORT FORM FOR INSPECTION AND TESTING OF LIQUID FILLED TRANSFORMERS (EVERY THREE YEARS) (WORK TO BE CARRIED OUT WITH THE TRANSFORMER DE-ENERGIZED)

TRANSFORMER RATING: ____ KVA

PRIMARY VOLTAGE: ____ V SECONDARY VOLTAGE: ____ V

MAXIMUM DEMAND: ____ KVA A ____ AMPS B ____ AMPS C ____ AMPS

LOCATION: ____

NAME PLATE INFORMATION: ____

Recommendations and follow-up:

Planned overhaul every 3 years: ☐ Yes ☐ No

Other interval: ..... years

Total downtime for overhaul: Estimated: .....

Actual: .....

Cost of planned overhaul: $ In-house staff

$ Contracted

Spare parts: $ _____

TOTAL: $ _____

VIII.H. (Cont'd)

	REMARKS
Check bushings Clear bushings Liquid leaks from: Gasket Drain valve Bus ring Obtain and test liquid sample	
Check tap changer and tightness of connections	
Measure ground connection resistance in Ohms.	
Cooling fans operation	
Verify contacts condition in thermostat	
Insulation resistance Low voltage winding to ground with high voltage winding grounded	.....MegaOhms
High voltage winding to ground with low voltage winding grounded	.....MegaOhms.
High voltage winding to low voltage winding	.....MegaOhms.

HIGH VOLTS	LOW VOLTS	TAP POSITION	CALCULATED RATIO
		1	
		2	
		3	
		4	
		5	

Tested and inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

IX. RELAYS

IX.A. TEST REPORT OVERCURRENT RELAY

RELAY MAKE: _____ SERIAL NO.: _____

NAME PLATE DATA: _____

LOCATION: _____ FEEDER: _____

INSULATION TESTS: _____ MEGAOHMS _____ MEGAOHMS

ZERO ADJUSTMENT: A _____ B _____ C _____

PHASE GROUND: _____

SETTINGS	AS FOUND			AS LEFT			AS FOUND			AS LEFT			REMARKS
	A	B	C	A	B	C	A	B	C	A	B	C	
Tap amps													
Time dial													
Inst. amps													
RELAY TESTS Pick-up amps. limit x tap = ... A													
Seconds													
Cycles													
Pick-up amps. limit x tap = ... A													
Seconds													
Cycles													
Pick-up amps. limit x tap = ... A													
Seconds													
Cycles													
Inst. Amps Target) I.C.S. Oper.) A.D.C.) O.I. Insul. M) HMS													

Tested by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required. 2. Follow manufacturer's instructions.

IX.B. TEST REPORT OVERVOLTAGE OR UNDERVOLTAGE RELAY

RELAY MAKE: _____ SERIAL NO.: _____

NAME PLATE DATA: _____

LOCATION: _____ FEEDER: _____

INSULATION TESTS: _____ MEGAOHMS _____ MEGAOHMS

ZERO ADJUSTMENT: A _____ B _____ C _____

PHASE GROUND: _____

SETTINGS	AS FOUND			AS LEFT			AS FOUND			AS LEFT			REMARKS
	A	B	C	A	B	C	A	B	C	A	B	C	
Tap volts													
Time dial													
Relay tests Pick-up volts x tap = ... V													
Seconds													
Cycles													
Pick-up volts x tap = ... V													
Seconds													
Cycles													
Cont. switch A													
Target oper. A.D.C.													

Tested by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

IX.C. TEST REPORT TYPE CA PERCENT DIFFERENTIAL RELAY

RELAY MAKE:

NAME PLATE DATA:

LOCATION:

FEEDER:

RELAY TESTS	RELAY			REMARKS
	Ser. No. ..... Position ..... Style No.	Ser. No. ..... Position ..... Style No.	Ser. No. ..... Position ..... Style No.	
Tap amp.				
Time dial				
Pick-up amp.				
Thro'fault test				
Slope test				
Target OP. A.D.C.				
Ins. test M-OHMS				
Amps.				
Cycles				

Tested by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instruction.

IX.D. TEST REPORT TYPE CW RELAY

RELAY MAKE:

NAME PLATE DATA:

RELAY TESTS	RELAY			REMARKS
	Ser. No. ..... Style No. ..... Position ..... Feeder	Ser. No. ..... Style No. ..... Position ..... Feeder	Ser. No. ..... Style No. ..... Position ..... Feeder	
Tap watts				
Time dial				
Pick-up watts				
x 2 V				
x 4 V				
6 x				
8 x				
10 x				
12 x				
Target A.D.C.				
Ins. test M-OHMS				
Zero adjustment				

Tested by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

X. ROTATING MACHINERY

X.A. MOTOR ORDER FORM

Rating of the motor: ..... H.P.
Speed: ..... R.P.M.
Voltage: ..... Volts
Frequency: ..... Hertz
Phases .....
Enclosure type: .....
Type of coupling: ☐ Direct-coupled ☐ Belt-drive
Type of control required: .....
Description of load or driven unit: .....
.....
.....
.....
.....

X.B. ROTATING MACHINERY HISTORY CARD

Motor: .....
Manufacturer: .....
H.P.: .....
R.P.M.: .....
Voltage: ..... volts
Current: ..... amps
Phase: .....
Cycles: ..... Hertz

Reference No.: .....

Frame: .....
Serial No.: .....
Model: .....
Bearing: .....

Location: .....
Description of load or driven unit: .....
.....
.....
.....

FAN	V-BELT DRIVE
C.F.M. ..... R.P.M.: ..... B.H.P.: ..... Shaft size: ..... Bearing	Belt No.: ..... Belt size: .....

Filter type: .....
Filter No.: .....
Filter size: .....
B.T.U. rating: .....

DATE	DESCRIPTION OF WORK	FREQUENCY D - daily W - weekly A - annually
	Check abnormal conditons such as noise, overheating, oil leaks, smell	D
	Remove motor, complete motor overhaul	Every 2 - 3 years

XI. MOTOR STARTERS CONTROL CENTRES AND CONTROL DEVICES

XI.A. REPORT FORM FOR ANNUAL INSPECTION AND TESTING PROGRAM FOR MOTOR STARTERS

STARTER DESIGNATION:

Type: ..... Size: .....

Rating: ..... Amps: .....

Voltage: ..... Phase: ..... H.P.

CONTROLS:

Push buttons: ..... HOA: .....

Interlocks: .....

Fuse/breaker: ..... Amps

Control voltage: ..... Volts

	REMARKS
Termination check and tighten	
Termination temperature Visible signs of overheating	
Clean and vacuum enclosure	
Mechanical operation	
Check and clean contacts	
Check and measure resistance of contacts	
Lubricate moving parts in accordance with manufacturer's recommendations	
Check and operate breaker switch	

Recommendations and follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

XII. POWER AND LIGHTING PANELS

XII.A. REPORT FORM FOR ANNUAL PANEL INSPECTION AND TESTING

Panel designation: .....

Panel type: .....

Voltage phase: .....

Panel mains: .....

Feeder rating ..... amps

Main breaker rating (at source): ..... amps

Panel make: .....

Number of circuits: .....

Type of breakers: .....

Phase A: ..... volts ..... amps

Phase B: ..... volts ..... amps

Phase C: ..... volts ..... amps

	REMARKS
Terminations	
Temperature	
Vacuum clean enclosure	
Condition of enclosure	
Legend completed	
Visible signs of overheating	

Recommendations and follow-up:

Location of Switchgear, Reference Number and Type: .....

.....

Time taken to complete the inspection: .....

Date of inspection: .....

Inspected by: ..... Date: .....

Approved by: ..... Date: .....

NOTES: 1. Above list shall be expanded as required.
2. Follow manufacturer's instructions.

FORM FOR COMMENTS

PREVENTIVE MAINTENANCE AND TESTING OF ELECTRICAL EQUIPMENT IN HEALTH CARE FACILITIES

RETURN TO: Senior Electrical Engineer
Capital Planning Branch
Ontario Ministry of Health
15 Overlea Blvd., 7th Floor
Toronto, Ontario
M4H 1A9

FROM:

Name . . . . . .

Title . . . . . .

Address . . . . . .

. . . . . .

. . . . . .

1. Page/Section/Paragraph:

2. Identification of wording to be changed or deleted:

3. Recommended new or revised text to be included:

4. Substantiation and reasons for recommended change:

Signed by: . . . . . .

Date: . . . . . .

Ministry of Health

Ontario

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